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Annual and semiannual harmonics of wind in the Northern stratosphere, mesosphere, and lower thermosphere

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Abstract

Based on the UK MetOffice gridded analysis in the altitudes from the tropopause to the mesopause of the Northern Hemisphere and the meteor radar observations in the mesosphere/lower thermosphere over Kazan ($56^\circ N$ $49^\circ E$) and Collm ($51^\circ N$ $13^\circ E$), the annual and semiannual harmonics of the horizontal wind components in the stratosphere, mesosphere, and lower thermosphere are studied for the period 2004–2013. The maxima of the amplitude of the annual harmonics of zonal wind are much more pronounced than the respective maxima for meridional wind. In contrast, the magnitudes of the maxima of the semiannual harmonics are comparable between zonal and meridional wind. The annual harmonics of horizontal wind in the studied layer typically reaches maximum in January–February. The semiannual harmonics of the components of horizontal wind in the stratosphere–lower thermosphere layer basically attains it first maximum in spring or in early summer. The results, included in the present paper, may be used for climate models validation.

Keywords: Stratosphere; Mesosphere; Lower thermosphere; Horizontal wind; Annual harmonics; Semiannual harmonics

1. Introduction

One of the most prominent feature of the Earth's climate is an annual cycle (AC) exhibited by all climatic variables. Its cause is the orbital movement of the Earth around the Sun. However, the annual cycle also includes a variety of feedbacks. Most of those feedbacks operate at the interannual and longer time scales as well. Despite a possible dependence of the efficiency of these feedbacks on the time scale of climate variations, an accurate simulation of AC might be considered as a prerequisite for realistic simulations of climate change at the decadal and longer time scales. Assessments of the annual cycle of surface air temperature as simulated by global climate models were performed earlier (Covey et al., 2000; Eliseev et al., 2004; Eliseev et al., 2004).

Recently, the so called CMIP5 (Coupled Models Intercomparison Project, phase 5) ensemble of climate models became available. In comparison to the earlier–generation models, the upper boundary is located at larger altitudes (up to 0.01 hPa in pressure coordinates, e.g., Manzini et al., 2014). Moreover, contemporary climate models start to include modules representing atmospheric chemistry. All this poses the necessity to extend the previous analysis for additional variables and for higher levels of the atmosphere.

A prerequisite for such an analysis is an assessment of the AC characteristics based on observations. Previous

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